



## **ATTACHMENT 4**

**Recommended Proposals on Ku-Band Sharing  
Adopted By the FCC's  
WRC-2000 Advisory Committee**

**Draft Proposals**

Document IWG-4/31 (Rev.3)

June 23, 1999

Author: IWG-4 Drafting Group 1

**United States of America  
[DRAFT] Proposals for Agenda Item 1.13.1**

“To review and, if appropriate, revise the power limits appearing in Articles S21 and S22 in relation to the sharing conditions among non-GSO FSS, GSO FSS, GSO broadcasting satellite service (BSS), space services, and terrestrial services, to ensure the feasibility of these power limits and that these limits do not impose undue constraints on the development of these systems and services.

**Background**

The report of CPM-99 to WRC-2000 states that “[t]here is a need to provide a regulatory mechanism that would ensure protection of GSO FSS and GSO BSS networks from the maximum aggregate equivalent power flux-density produced by multiple non-GSO FSS systems in frequency bands where equivalent power flux-density (EPFD) limits have been adopted.” CPM-99 Report at Section 3.1.1.3.2. With respect specifically to the GSO BSS, Section 3.1.3.1.4(b) of the CPM-99 Report to WRC-2000 states that “[t]here is a need to ensure that the aggregate EPFD produced by all co-frequency non-GSO FSS systems does not exceed the maximum interference levels, as determined by the agreed to aggregate EPFD masks, that are necessary to protect these GSO BSS systems.”

The United States strongly agrees with these assessments, and believes that the required regulatory mechanism can only be provided in the form of aggregate limits that are included in Article S22 or attached to a WRC-2000 Resolution. Because a WRC-2000 Resolution would be an acceptable mechanism, the United States proposes the Resolution included in the attachment, which is based in substantial part on studies performed in the ITU-R.

## Proposals

### 1. USA/1.13.1/4

#### RESOLUTION WWW (WRC-2000)

#### **PROTECTION OF GSO FSS AND GSO BSS NETWORKS FROM THE MAXIMUM AGGREGATE EQUIVALENT POWER FLUX-DENSITY PRODUCED BY MULTIPLE NON-GSO FSS SYSTEMS IN FREQUENCY BANDS WHERE EPFD LIMITS HAVE BEEN ADOPTED**

The World Radiocommunication Conference (WRC-2000, Istanbul),

*considering*

- a) that WRC-97 has adopted, in Article **S22**, provisional EPFD limits to be met by non-GSO FSS systems in order to protect GSO FSS and GSO BSS networks in parts of the frequency range 10.7 - 30 GHz;
- b) that WRC-2000 has revised these limits to ensure that they provide adequate protection to GSO systems without causing undue constraints to any of the systems and services sharing these frequency bands;
- c) that Article **S22** includes single entry EPFD limits which apply to non-GSO FSS systems in these bands;
- d) that these single-entry limits have been derived from aggregate equivalent power flux-density (EPFD) masks that are intended to protect GSO networks, assuming a maximum effective number of non-GSO FSS systems of 3.5;
- e) that the aggregate interference caused by all co-frequency non-GSO FSS systems in these bands into GSO FSS systems should not exceed the maximum interference levels that are necessary to protect these GSO systems;
- f) that WRC-97 decided, and WRC-2000 confirmed, that non-GSO FSS systems in these bands are to coordinate the use of these frequencies between themselves under the provisions of No. **S9.12** of the Radio Regulations;
- g) that the orbital characteristics of such systems are likely to be inhomogeneous;
- h) that as a result of this likely inhomogeneity, the aggregate EPFD levels from multiple non-GSO FSS systems are not directly related to the number of actual systems sharing a frequency band, and the number of such systems operating co-frequency is likely to be small,

*recognizing*

- a) that non-GSO FSS systems are likely to need to implement interference mitigation techniques to share frequencies among themselves;

- b) that because the use of such interference mitigation techniques will likely keep the number of non-GSO systems small, the aggregate interference caused by non-GSO FSS systems into GSO systems will also likely be small;
- c) that notwithstanding *considering* d), there may be instances where the aggregate interference from non-GSO systems could exceed the interference levels given in Annex 1;
- d) that administrations operating GSO systems may wish to ensure that the aggregate EPFD produced by all operating co-frequency non-GSO FSS systems in the frequency bands referred to in *considering* a) above into GSO FSS and/or GSO BSS networks does not exceed the aggregate interference levels given in Annex 1,

*resolves*

1 that administrations operating or planning to operate non-GSO FSS systems in the frequency bands referred to in *considering* a) above, individually or in collaboration, take all possible steps, including by means of appropriate modifications to their systems if necessary, to ensure that the actual aggregate interference into GSO FSS and GSO BSS networks caused by such systems operating co-frequency in these frequency bands does not exceed the aggregate power levels shown in Annex 1;

2 that, in the event that the aggregate interference levels in Annex 1 are exceeded into an operational GSO earth station, administrations operating non-GSO FSS systems in these frequency bands shall expeditiously take all necessary measures to reduce the aggregate EPFD levels to those in Annex 1 or to reduce such interference to higher levels that are acceptable to the affected GSO administration.

*requests ITU-R*

1 to develop, as a matter of urgency, and complete, in time for consideration by the next WRC, a methodology for calculating the aggregate EPFD produced by all non-GSO FSS systems operating or planning to operate co-frequency in the frequency bands referred to in *considering* a) above into GSO FSS and GSO BSS networks and for comparing the calculated levels with the aggregate power levels shown in Annex 1;

2 to continue its studies on the accurate modelling of interference from non-GSO FSS systems into GSO FSS and GSO BSS networks in the frequency bands referred to in *considering* a) above in order to assist the administrations planning or operating non-GSO FSS systems in their efforts to limit the aggregate EPFD levels produced by their systems into GSO networks.

*requests the Director of the Radiocommunication Bureau*

to assist in the development of the methodology referred to in *requests ITU-R* 1 above.

# ANNEX 1 (TO RESOLUTION WWW)

This Annex to Resolution WWW contains tables of interference levels concerning aggregate interference from multiple non-GSO FSS systems into GSO FSS and GSO BSS systems.

**TABLE 1A-FSS <sup>1</sup>**

**Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
10.7 – 11.7; 11.7 – 12.2 in Region 2; 12.2 – 12.5 in Region 3 and 12.5 – 12.75 in Regions 1 and 3	-170.0	0	40	60 cm Rec. S.[4/57]
	-168.6	90		
	-165.3	99		
	-160.4	99.97		
	-160.0	99.99		
	-160.0	100		
	-176.5	0	40	1.2 m Rec. S.[4/57]
	-173.0	99.5		
	-164.0	99.84		
	-161.6	99.945		
	-161.4	99.97		
	-160.8	99.99		
	-160.5	99.99		
	-160	99.9975		
	-160	100		
	-185.0	0	40	3 m Rec. S.[4/57]
	-184.0	90		
	-182.5	99.1		
	-160	99.999		
	-160	100		
	-190.0	0	40	10 m Rec. S.[4/57]
	-190.0	99.9		
	-163.0	99.999		
	-163.0	100		

<sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

**Editorial Note to Table 1A-FSS:** The US proposal included in Table 1A-FSS for the 3 meter and 10 meter antenna diameters reflect in tabular form Curve B from Figures 1 and 2, respectively, in Section 3.1.2.1.4(c) of the draft CPM Report. An alternative set of curves (Curve A from Figures 1 and 2, respectively), is also included in Section 3.1.2.1.4(c) in the draft CPM Report. A set of values based on the alternative set of curves, which is not supported by the US, is provided in tabular form below:

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
10.7 – 11.7; 11.7 – 12.2 in Region 2; 12.2 – 12.5 in Region 3 and 12.5 – 12.75 in Regions 1 and 3	-185 -184 -182.5 -182 -168 -164 -161.8 -160 -160	0 90 99 99.5 99.9 99.96 99.985 99.997 100	40	3 m Rec. S.[4/5 <sup>7</sup> ]
	-190 -190 -166 -160 -160	0 99 99.991 99.998 100	40	10 m Rec. S.[4/5 <sup>7</sup> ]

No agreement was reached within the ITU-R and work is continuing in an effort to reach a compromise between the two sets of limits, or to agree on other mutually acceptable solutions.

**TABLE 1B-FSS<sup>1</sup>**

**Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

<b>Frequency Band (GHz)</b>	<b>Epfd<sub>down</sub> dB(W/m<sup>2</sup>)</b>	<b>Percentage of time during which Epfd<sub>down</sub> may not be exceeded</b>	<b>Reference Bandwidth (kHz)</b>	<b>Reference antenna diameter, and reference radiation pattern<sup>2</sup></b>
17.8-18.6	-170	0	40 <sup>3</sup>	1 m Rec. S.[4/57]
	-170	90		
	-164	99.9		
	-164	100		
17.8-18.6	-173	0	40 <sup>3</sup>	2 m Rec. S.[4/57]
	-173	99.4		
	-166	99.9		
	-164	99.92		
	-164	100		
17.8-18.6	-180	0	40 <sup>3</sup>	5 m Rec. S.[4/57]
	-180	99.8		
	-172	99.8		
	-164	99.992		
	-164	100		

<sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

<sup>3</sup> For non-GSO emission bandwidths greater than 40 kHz, the epfd<sub>down</sub> limits may be scaled by adding 10 log(non-GSO emission bandwidth / 40 kHz) in a reference bandwidth equal to the emission bandwidth.



**TABLE 1C-FSS<sup>1</sup>**

**Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

<b>Frequency Band (GHz)</b>	<b>Epfd<sub>down</sub> dB(W/m<sup>2</sup>)</b>	<b>Percentage of time during which Epfd<sub>down</sub> may not be exceeded</b>	<b>Reference Bandwidth (kHz)</b>	<b>Reference antenna diameter, and reference radiation pattern<sup>2</sup></b>
19.7-20.2	-182	0	40 <sup>3</sup>	70 cm Rec. S.[4/57]
	-172	90		
	-154	99.94		
	-154	100		
19.7-20.2	-185	0	40 <sup>3</sup>	90 cm Rec. S.[4/57]
	-176	91		
	-165	99.8		
	-160	99.8		
	-154	99.99		
	-154	100		
19.7-20.2	-193	0	40 <sup>3</sup>	2.5 m Rec. S.[4/57]
	-185	90		
	-166	99.99		
	-160	99.99		
	-154	99.998		
	-154	100		

<sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

<sup>3</sup> For non-GSO emission bandwidths greater than 40kHz, the epfd<sub>down</sub> limits may be scaled by adding 10 log(non-GSO emission bandwidth / 40 kHz) in a reference bandwidth equal to the emission bandwidth.

*Editorial Note to Table 1C-FSS: The table below contains the aggregate EPFD<sub>down</sub> masks for the 2.5 and 5 meter antennas in the 19.7-20.2 GHz band supported by the majority of participants at the final JTG 4-9-11 meeting and included in the draft CPM Report.*

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
19.7-20.2	-191 -154.35 -154.35	0 99.99 100	40	2.5 m Rec. S.[4/57]
19.7-20.2	-195 -184 -175 -154.35 -154.35	0 90 99.6 99.996 100	40	5 m Rec. S [4/57]

Due to the late introduction of this proposal, nearing the end of the meeting, the U.S. was unable to agree to these masks. Nevertheless, the U.S. is continuing to work towards resolving the differences between the two masks for the 2.5 meter antenna. It is noted that the U.S. does not currently see the need for an EPFD<sub>down</sub> mask for the 5 meter antenna diameter in this band, and is of the view that the final 2.5 meter mask should also protect antenna sizes up to 3.5 meters

**TABLE 1D-BSS**

**Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

**30cm, 45cm, and 60cm BSS antennas**

Frequency band (GHz)	Epdf <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which Epdf <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>1</sup>
11.7 – 12.5 GHz In Region 1	-160.400 -160.100 -158.600	0.000 25.000 96.000	40	30 cm DNR ITU-R BO.[Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-158.600	98.000		
12.5 – 12.75 GHz In Region 3	-158.330 -158.330	98.000 100.000		
12.2 – 12.7 GHz In Region 2				
11.7 – 12.5 GHz In Region 1	-170.000 -167.000 -164.000	0.000 66.000 97.750	40	45 cm DNR ITU-R BO.[Doc. 11/137 Annex 1]
11.7 – 12.2 GHz and	-160.750	99.330		
12.5 – 12.75 GHz	-160.750	99.330		

In Region 3	-160.000	99.950		
12.2 – 12.7 GHz	-159.900	100.000		
In Region 2				
11.7 – 12.5 GHz	-171.000	0.000		
In Region 1	-168.750	90.000		
11.7 – 12.2 GHz	-167.750	97.800		
and	-162.000	99.600	40	60 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
12.5 – 12.75 GHz	-161.000	99.800		
In Region 3	-160.200	99.900		
12.2 – 12.7 GHz	-160.000	99.990		
In Region 2	-159.900	100.000		

<sup>1</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

**TABLE 1E-BSS**

**Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

**90cm and 120cm BSS antennas**

Frequency band (GHz)	Epfd <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which Epfd <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>1</sup>
11.7 – 12.5 GHz	-173.75	0.000		
In Region 1	-173	33.000		
11.7 – 12.2 GHz	-171	98.000		
and	-165.5	99.100	40	90 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
12.5 – 12.75 GHz	-163	99.500		
In Region 3	-161	99.800		
12.2 – 12.7 GHz	-160	99.970		
In Region 2	-159.9	100.000		
11.7 – 12.5 GHz	-177.000	0.000		
In Region 1	-175.250	90.000		
	-173.750	98.900		
	-173.000	98.900		120 cm

11.7 – 12.2 GHz and 12.5 – 12.75 GHz	-169.500	99.500	40	DNR ITU-R BO. [Doc. 11/137 Annex 1]
In Region 3	-164.000	99.820		
12.2 – 12.7 GHz	-161.900	99.900		
In Region 2	-161.000	99.965		
	-160.400	99.993		
	-159.900	100		

- <sup>1</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

TABLE 1F-BSS

Limits to the aggregate EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

180cm and 240cm BSS antennas

Frequency band (GHz)	Epfd <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which Epfd <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>1</sup>
11.7 – 12.5 GHz	-192.8	0	4	180 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
In Region 1	-192.8	96.06		
11.7 – 12.2 GHz	-188	98.37		
and	-185	99.06		
12.5 – 12.75 GHz	-182	99.46		
In Region 3	-178.8	99.7		
12.2 – 12.7 GHz	-178.8	100	4	240 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
In Region 2				
11.7 – 12.5 GHz	-195	0		
In Region 1	-195	99.24		
11.7 – 12.2 GHz	-193	99.48		
and	-190	99.70		
12.5 – 12.75 GHz	-187	99.83		
In Region 3	-184	99.9		
12.2 – 12.7 GHz	-184	100		
In Region 2				

<sup>1</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

*Editorial Note to Table 1F-BSS: Recognizing the work performed to date by the ITU-R and the masks included in Chapter 3 of the CPM Report, further analysis is being conducted on the proposed BSS EPFD<sub>down</sub> masks for the 180 cm and 240 cm antenna sizes. For example, the possibility of a latitude dependent EPFD<sub>down</sub> level for 100 percent of the time is under study with a view to relaxing the 100% EPFD<sub>down</sub> level of the U.S. proposed masks in Table 1F-BSS.*

**Reasons:** The ITU-R has determined that it is necessary to provide a regulatory mechanism that ensures the protection of GSO FSS and GSO BSS networks from the maximum aggregate equivalent power flux-density produced by multiple non-GSO FSS systems in frequency bands where EPFD limits have been adopted. The foregoing Resolution, which is in the form of the example resolution suggested by CPM-99-2, is the only such regulatory mechanism other than inclusion of the aggregate EPFD limits in Article S22 that would provide the necessary protection of GSO FSS and GSO BSS networks.



## **Draft Proposals**

Document IWG-4/26 (Rev.4)  
June 23, 1999  
Author: IWG-4 Drafting Group 1

### **United States of America [DRAFT] Proposals for Agenda Item 1.13.1**

"To review and, if appropriate, revise the power limits appearing in Articles S21 and S22 in relation to the sharing conditions among non-GSO FSS, GSO FSS, GSO broadcasting satellite service (BSS), space services, and terrestrial services, to ensure the feasibility of these power limits and that these limits do not impose undue constraints on the development of these systems and services.

#### **Background**

Resolution 130 (WRC-97) and Resolution 538 (WRC-97) each requested the ITU-R to conduct (a) "appropriate technical, operational and regulatory studies" to review the regulatory conditions relating to the coexistence of non-GSO FSS and GSO FSS and GSO BSS systems, in order to ensure that undue constraints are not placed on the development of non-GSO FSS, GSO FSS and GSO BSS systems, and (b) the development of a methodology for calculating the power levels produced by non-GSO FSS systems and the compliance of these levels with the applicable limits established pursuant to Resolutions 130 and 538.

Joint Task Group 4-9-11 was established by the ITU-R to pursue these mandates and to determine the necessary technical bases. Taking into account the work of the ITU-R on this matter, the United States makes the following proposals for **Section II** of Article S22.

**Proposals:**

1. USA/1.13.1/1

**SUP S22.5B, S22.5C, S22.5D, S22.5E, and S22.5F**

**Reasons:** Proposed Sections **ADD S22.5B, ADD S22.5C, ADD S22.5D, ADD S22.5E, ADD S22.5F, ADD S22.5G, and ADD S22.5H** below, which are based in substantial part on work that has been performed in the ITU-R since WRC-97 established current Nos. **S22.5B, S22.5C, S22.5D, S22.5E, and S22.5F** are intended to be a package that would replace and supplement the current provisions of much of Section II of Article S22.

2. USA/1.13.1/2

**NOC S22.2, S22.3, S22.4, S22.5, S22.5A**

**Reasons:** These provisions are not directly affected by the review of the EPFD limits that was carried out pursuant to Resolution 130, and should remain unchanged.

3. USA/1.13.1/3

**ADD S22.5B, S22.5C, S22.5D, S22.5E, S22.5F, S22.5G, and S22.5H**

**Reasons:** These provisions, which are based in substantial part on the studies carried out by the ITU-R pursuant to Resolution 130, are intended to replace in their entirety the existing Regulations currently found in Nos. **S22.5B to S22.5F**, inclusive. The application of EPFD<sub>up</sub> limits as per Table S22-2 is specifically limited to the bands specified in that table.

**ADD S22.5B**      § 5      1)      The equivalent power flux-density<sup>xx</sup>, EPFD<sub>down</sub>, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Tables **S22-1A** through **S22-1F**, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Tables **S22-1A** through **S22-1F** for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Tables **S22-1A** through **S22-1F**, for all pointing directions towards the geostationary-satellite orbit.



**XX ADD S22.5B.1**

The equivalent power flux-density is defined as the sum of the power flux-densities produced at a GSO receive station on the Earth's surface or in the geostationary orbit, as appropriate, by all the transmit stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing in its nominal direction. The equivalent power flux-density is calculated using the following formula:

$$EPFD = 10 \cdot \log_{10} \left[ \sum_{i=1}^{N_a} 10^{\frac{P_i}{10}} \cdot \frac{G_t(\theta_i)}{4\pi d_i^2} \cdot \frac{G_r(\phi_i)}{G_{r,max}} \right]$$

where:

- $N_a$  is the number of transmit stations in the non-geostationary-satellite system that are visible from the GSO receive station considered on the Earth's surface or in the geostationary orbit, as appropriate
- $i$  is the index of the transmit station considered in the non-geostationary-satellite system
- $P_i$  is the RF power at the input of the antenna of the transmit station, considered in the non-geostationary satellite system in dBW in the reference bandwidth
- $\theta_i$  is the off-axis angle between the boresight of the transmit station considered in the non-geostationary satellite system and the direction of the GSO receive station
- $G_t(\theta_i)$  is the transmit antenna gain (as a ratio) of the station considered in the non-geostationary satellite system in the direction of the GSO receive station
- $d_i$  is the distance in metres between the transmit station considered in the non-geostationary satellite system and the GSO receive station
- $\phi_i$  is the off-axis angle between the boresight of the antenna of the GSO receive station and the direction of the  $i$ th transmit station considered in the non-geostationary satellite system
- $G_r(\phi_i)$  is the receive antenna gain (as a ratio) of the GSO receive station in the direction of the  $i$ th transmit station considered in the non-geostationary satellite system
- $G_{r,max}$  is the maximum gain (as a ratio) of the antenna of the GSO receive station
- $EPFD$  is the computed equivalent power flux-density in dB(W/m<sup>2</sup>) in the reference bandwidth

ADD TABLE S22-1A<sup>1</sup>

Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
10.7 - 11.7: 11.7 - 12.2 in Region 2: 12.2 - 12.5 in Region 3 and 12.5 - 12.75 in Regions 1 and 3	-175.4	0	40	60 cm Rec. S.[4/57]
	-174.0	90		
	-170.8	99		
	-165.3	99.73		
	-160.4	99.991		
	-160.0	99.997		
	-160.0	100		
	-181.9	0	40	1.2 m Rec. S.[4/57]
	-178.4	99.5		
	-173.4	99.74		
	-173.0	99.857		
	-164.0	99.954		
	-161.6	99.984		
	-161.4	99.991		
	-160.8	99.997		
	-160.5	99.997		
	-160.0	99.9993		
	-160.0	100		
	-190.4	0	40	3 m Rec. S.[4/57]
	-189.4	90		
	-188.0	99		
	-182.5	99.743		
	-160.0	99.9997		
	-160.0	100		
	-195.4	0	40	10 m Rec. S.[4/57]
	-195.4	99.9		
	-190	99.96		
	-190	99.971		
	-163	99.9997		
	-163	100		

<sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

*Editorial Note to Table S22-1A: The US proposal included in Table S22-1A for the 3 meter and 10 meter antenna diameters reflects in tabular form single-entry values derived from Curve B from Figures 1 and 2, respectively, in Section 3.1.2.1.4(c) of the draft CPM Report. An alternative set of curves (Curve A from Figures 1 and 2, respectively), is also included in Section 3.1.2.1.4(c) in the draft CPM Report. A set of single entry values based on the alternative set of curves, which is not supported by the US, is provided in tabular form below:*

<b>Frequency band (GHz)</b>	<b>EPFD<sub>down</sub> dB(W/m<sup>2</sup>)</b>	<b>Percentage of time during which EPFD<sub>down</sub> may not be exceeded</b>	<b>Reference bandwidth (kHz)</b>	<b>Reference antenna diameter, and reference radiation pattern<sup>2</sup></b>
10.7 – 11.7; 11.7 – 12.2 in Region 2; 12.2 – 12.5 in Region 3 and 12.5 – 12.75 in Regions 1 and 3	-190.4	0	40	3 m Rec. S.[4/57]
	-189.4	90		
	-187.9	99		
	-187.4	99.5		
	-182.4	99.725		
	-182	99.857		
	-168	99.971		
	-164	99.989		
	-161.8	99.9957	40	10 m Rec. S.[4/57]
	-160	99.9991		
	-160	100		
	-195.4	0		
	-195.4	99		
	-190	99.65		
	-190	99.714		
	-173	99.99		
	-160	99.999		
	-160	100		

*No agreement was reached within the ITU-R and work is continuing in an effort to reach a compromise between the two sets of limits, or to agree on other mutually acceptable solutions.*

**ADD TABLE S22-1B<sup>1</sup>**  
**Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

Frequency Band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference pattern <sup>2</sup>
17.8-18.6	-175.4	0	40 <sup>3</sup>	1 m Rec. S.[4/57]
	-175.4	90		
	-172.5	99		
	-167	99.714		
	-164	99.971		
	-164	100		
17.8-18.6	-178.4	0	40 <sup>3</sup>	2 m Rec. S.[4/57]
	-178.4	99.4		
	-171.4	99.9		
	-170.5	99.913		
	-166	99.971		
	-164	99.977		
17.8-18.6	-164	100		
	-185.4	0	40 <sup>3</sup>	5 m Rec. S.[4/57]
	-185.4	99.8		
	-180	99.8		
	-180	99.943		
	-172	99.943		
	-164	99.998		
	-164	100		

<sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

<sup>3</sup> For non-GSO emission bandwidths greater than 40 kHz, the EPFD<sub>down</sub> limits may be scaled by adding 10 log(non-GSO emission bandwidth / 40 kHz) in a reference bandwidth equal to the emission bandwidth.

# ADD TABLE S22-1C<sup>1</sup>

Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

Frequency Band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference Bandwidth (kHz)	Reference antenna diameter, and reference pattern
19.7-20.2	-187.4	0	40 <sup>3</sup>	70 cm Rec. S.[4/57]
	-182	71.429		
	-172	97.143		
	-154	99.983		
	-154	100		
19.7-20.2	-190.4	0	40 <sup>3</sup>	90 cm Rec. S.[4/57]
	-181.4	91		
	-170.4	99.8		
	-168.6	99.8		
	-165	99.943		
	-160	99.943		
	-154	99.997		
	-154	100		
19.7-20.2	-198.4	0	40 <sup>3</sup>	2.5 m Rec. S.[4/57]
	-190.4	90		
	-171.4	99.99		
	-169.4	99.99		
	-166	99.99714		
	-160	99.99714		
	-154	99.99943		
	-154	100		

- <sup>1</sup> For certain receive earth stations, see also ADD S9.7A and ADD S9.7B.
- <sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.
- <sup>3</sup> For non-GSO emission bandwidths greater than 40 kHz, the EPFD<sub>down</sub> limits may be scaled by adding 10 log(non-GSO emission bandwidth / 40 kHz) in a reference bandwidth equal to the emission bandwidth.

*Editorial Note to Table S22-1C: The table below contains the single-entry EPFD<sub>down</sub> masks for the 2.5 and 5 meter antennas in the 19.7-20.2 GHz band supported by the majority of participants at the final JTG 4-9-11 meeting and included in the draft CPM Report.*

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
19.7-20.2	-196.4 -154.35 -154.35	0 99.9971 100	40	2.5 m Rec. S. [4/57]
19.7-20.2	-200.4 -195 -189.4 -189 -184 -175 -163.5 -154.35 -154.35	0 66 90 92 97.143 99.886 99.99 99.999 100	40	5 m Rec. S [4/57]

Due to the late introduction of this proposal, nearing the end of the meeting, the U.S. was unable to agree to these masks. Nevertheless, the U.S. is continuing to work towards resolving the differences between the two masks for the 2.5 meter antenna. It is noted that the U.S. does not currently see the need for an EPFD<sub>down</sub> mask for the 5 meter antenna diameter in this band, and is of the view that the final 2.5 meter mask should also protect antenna sizes up to 3.5 meters.

#### ADD TABLE S22-1D

Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

30cm, 45cm and 60cm BSS antennas

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> ) <sup>1</sup>	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and 12.5 – 12.75 GHz In Region 3 12.2 – 12.7 GHz In Region 2	-165.841 -165.541 -164.041 -158.600 -158.600 -158.330 -158.330	0.000 25.000 96.000 98.857 99.429 99.429 100.000	40	30 cm DNR ITU-R BO. [Doc. 11/137 Annex 1]
11.7 – 12.5 GHz In Region 1 11.7 – 12.2 GHz and	-175.441 -172.441 -169.441 -164.000	0.000 66.000 97.750 99.357	40	45 cm DNR ITU-R BO. [Doc. 11/137]

12.5 – 12.75 GHz	-160.750	99.809		Annex 1]
In Region 3	-160.000	99.986		
12.2 – 12.7 GHz	-159.900	100.000		
In Region 2				
11.7 – 12.5 GHz	-176.441	0.000		
In Region 1	-173.191	97.800		
11.7 – 12.2 GHz	-167.750	99.371		
and	-162.000	99.886	40	60 cm DNR ITU-R BO.[Doc. 11/137 Annex 1]
12.5 – 12.75 GHz	-161.000	99.943		
In Region 3	-160.200	99.971		
12.2 – 12.7 GHz	-160.000	99.997		
In Region 2	-159.900	100.000		

<sup>1</sup> For checking compliance with these limits, the BR software will use increments of 0.1 dB and will test against the fractionally more severe value: for example where the EPFD<sub>down</sub> limit is -165.841 dB(W/m<sup>2</sup>/40 kHz) the software will test against a criterion of -165.9 dB(W/m<sup>2</sup>/40 kHz).

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

#### ADD TABLE S22-1E

#### Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

##### 90cm and 120cm BSS antennas

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> ) <sup>1</sup>	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
11.7 – 12.5 GHz	-178.94	0.000		
In Region 1	-178.44	33.000		
11.7 – 12.2 GHz	-176.44	98.000		
and	-171.00	99.429		90 cm
12.5 – 12.75 GHz	-165.50	99.714	40	DNR ITU-R BO. [Doc. 11/137 Annex 1]
In Region 3	-163.00	99.857		
12.2 – 12.7 GHz	-161.00	99.943		
In Region 2	-160.00	99.991		
	-159.90	100.000		
	-182.440	0.000		
	-180.690	90.000		

	-179.190	98.900		
11.7 – 12.5 GHz	-178.440	98.900		
In Region 1	-174.940	99.500		
11.7 – 12.2 GHz and	-173.750	99.680		120 cm
12.5 – 12.75 GHz	-173.000	99.680	40	DNR ITU-R BO. [Doc. 11/137 Annex 1]
In Region 3	-169.500	99.850		
12.2 – 12.7 GHz	-167.800	99.915		
In Region 2	-164.000	99.940		
	-161.900	99.970		
	-161.000	99.990		
	-160.400	99.998		
	-159.900	100		

<sup>1</sup> For checking compliance with these limits, the BR software will use increments of 0.1 dB and will test against the fractionally more severe value: for example where the EPFD<sub>down</sub> limit is -165.841 dB(W/m<sup>2</sup>/40 kHz) the software will test against a criterion of -165.9 dB(W/m<sup>2</sup>/40 kHz).

<sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

#### ADD TABLE S22-1F

Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands

180cm and 240cm BSS antennas

Frequency band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> ) <sup>1</sup>	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern <sup>2</sup>
	-198.24	0		
11.7 – 12.5 GHz	-198.24	96.92		
In Region 1	-196	97.96		180 cm
11.7 – 12.2 GHz and	-192	99.03	4	DNR ITU-R BO. [Doc. 11/137 Annex 1]
12.5 – 12.75 GHz	-188	99.53		
In Region 3	-185	99.73		
12.2 – 12.7 GHz	-182	99.85		
In Region 2	-178.8	99.91		
	-178.8	100		
	-200.4	0		



	-200.4	99.41		
11.7 – 12.5 GHz	-198	99.62		
In Region 1	-195	99.78		
11.7 – 12.2 GHz and	-193	99.85		240 cm
12.5 – 12.75 GHz	-190	99.91	4	DNR ITU-R BO.
In Region 3	-187	99.95		[Doc. 11/137
12.2 – 12.7 GHz	-184	99.97		Annex 1]
In Region 2	-184	100		

- <sup>1</sup> For checking compliance with these limits, the BR software will use increments of 0.1 dB and will test against the fractionally more severe value: for example where the EPFD<sub>down</sub> limit is -165.841 dB(W/m<sup>2</sup>/40 kHz) the software will test against a criterion of -165.9 dB(W/m<sup>2</sup>/40 kHz).
- <sup>2</sup> Under this Section, reference patterns are to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS and BSS systems.

*Editorial Note to Table S22-1F: Recognizing the work performed to date by the ITU-R and the masks included in Chapter 3 of the CPM Report, further analysis is being conducted on the proposed BSS EPFD<sub>down</sub> masks for the 180 cm and 240 cm antenna sizes. For example, the possibility of a latitude dependent EPFD<sub>down</sub> level for 100 percent of the time is under study with a view to relaxing the 100% EPFD<sub>down</sub> level of the U.S. proposed masks in Table S22-1F.*

**ADD S22.5C**

2) The equivalent power flux-density<sup>xx</sup>, EPFD<sub>up</sub>, produced at any point in the geostationary-satellite orbit by emissions from all the earth stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table S22-2, for all conditions and for all methods of modulation, shall not exceed the limits given in Table S22-2 for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth specified in Table S22-2, for all pointing directions towards the Earth's surface visible from the geostationary-satellite orbit.

**ADD TABLE S22-2**

**Limits to the EPFD<sub>up</sub> radiated by non-GSO FSS systems in certain frequency bands**

Frequency band (GHz)	EPFD <sub>up</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>up</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern <sup>2</sup>
12.50 - 12.75 12.75 - 13.25 13.75 - 14.5	-160	100	40	4 degrees ITU-R S.672, L <sub>s</sub> = -20 <sup>1</sup>
17.3-17.8 Region 1 and Region 3 <sup>3</sup> 17.8-18.1	-160	100	40	4 degrees ITU-R S.672, L <sub>s</sub> = -20 <sup>1</sup>
27.5 - 28.6	-162	100	40	1.55 degrees ITU-R S.672, L <sub>s</sub> = -10 <sup>1</sup>
29.5 - 30.0	-162	100	40	1.55 degrees ITU-R S.672, L <sub>s</sub> = -10 <sup>1</sup>

<sup>1</sup> For the case of L<sub>s</sub>=-10, the values a=1.83 and b=6.32 should be used in the equations in Annex 1 of Recommendation ITU-R S.672 for single-feed circular beams. In all cases of L<sub>s</sub>, the parabolic main beam equation should start at zero.

<sup>2</sup> Under this Section, this reference pattern is to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

<sup>3</sup> Although the 17.3-17.8 GHz band is not allocated to non-GSO FSS in Region 2, this EPFD<sub>up</sub> level also applies to the frequency band 17.3-17.8 GHz to protect BSS feeder links in Region 2 from non-GSO FSS Earth-to-space transmissions in Regions 1 and 3.

- ADD S22.5D** 3) The equivalent power flux-density<sup>xx</sup>, EPFD<sub>is</sub>, produced at any point in the geostationary-satellite orbit by emissions from all the space stations in a non-geostationary-satellite system in the fixed-satellite service in the frequency bands listed in Table S22-3, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table S22-3 for the specified percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions into a reference antenna and in the reference bandwidth specified in Table S22-3, for all pointing directions towards the Earth's surface visible from the geostationary-satellite orbit.

**ADD TABLE S22-3**

**Limits to the EPFD<sub>is</sub> radiated by non-GSO FSS systems in certain frequency bands**

Frequency band (GHz)	EPFD <sub>is</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>is</sub> may not be exceeded	Reference bandwidth (kHz)	Reference antenna beamwidth and reference radiation pattern <sup>1</sup>
10.7 - 11.7 (Region 1) 12.5 - 12.75 (Region 1) 12.7 - 12.75 (Region 2)	-160	100	40	4 degrees ITU-R S.672, L <sub>s</sub> = -20
17.8 - 18.4	-160	100	40	4 degrees ITU-R S.672, L <sub>s</sub> = -20

<sup>1</sup> Under this Section, this reference pattern is to be used only for the calculation of interference from non-GSO FSS systems into GSO FSS systems.

- ADD S22.5E** The limits given in Tables S22-1A through S22-1F may be exceeded on the territory of any country whose Administration has so agreed.

- ADD S22.5F** The limits specified in No S22.5B to S22.5D apply to non-GSO FSS systems for which complete notification information has been received after 22 November 1997.

**ADD S22.5G**

An administration operating a non-GSO FSS system which is in compliance with the limits in No. **S22.5B** to **S22.5D** (see also Resolution WWWW) shall be considered as having fulfilled its obligations under No. **S22.2** with respect to any GSO network, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO system and of the complete coordination information for the GSO network, provided that the EPFD<sub>down</sub> radiated by the non-GSO FSS system into any operating GSO FSS earth station does not exceed the operational limits given in Table **S22-4**, when the gain of this earth station is equal to or greater than the corresponding value given in Table **S22-4** for the corresponding orbital inclination of the GSO FSS satellite as given in Table **S22-4**.

**ADD TABLE S22-4**

**Operational Limits to the EPFD<sub>down</sub> radiated by non-GSO FSS systems in certain frequency bands**

Frequency Band (GHz)	EPFD <sub>down</sub> dB(W/m <sup>2</sup> )	Percentage of time during which EPFD <sub>down</sub> may not be exceeded	Reference Bandwidth (kHz)	Receive GSO earth station antenna Gain (dBi)	Orbital inclination of GSO satellite
10.7 - 12.75 GHz	-163	100	40	≥59	≤2.5°
	TBD	100	40	≥49	≤2.5°
	[-160]	100	40	≥59	>2.5 and ≤4.5°
19.7 - 20.2 GHz	-157	100	40	≥55	≤2.5
	-157	100	40	≥43 <sup>1</sup>	≤2.5

<sup>1</sup> The operational limit applies only to non-GSO systems operating at altitudes of 7000 km or above in order to protect GSO FSS systems employing adaptive coding.

**ADD S22.5H**

In case of *force majeure*, telecommand and ranging carriers transmitted to non-geostationary satellites in the fixed-satellite service are not subject to the limits given in Table **S22-2**.

**June 24, 1999**

**Source: IWG-4**

### **Power Limitations for the FSS (Earth-to-space) in the 10-30 GHz Bands**

The IWG-4 addressed the issue of including in the Radio Regulations off-axis power limitations for the Fixed-Satellite Service (Earth-to-space).

At WRC-97 such power limitations for the FSS (Earth-to-space) were included in Article S22 Section VI of the Radio Regulations in the bands 12.75-13.25 GHz, 13.75-14 GHz and 14-14.5 GHz but were suspended pending the review of the values included by WRC-99. WRC-97 did not include any power limits in the Radio Regulations (suspended or otherwise) for the 27.5-30 GHz band.

In considering this issue, ITU-R Joint Task Group 4-9-11 made some progress on the appropriate levels for off-axis power from fixed-satellite service earth stations in certain bands, but did not attempt to state a conclusion on whether off-axis power limits should be included in the Radio Regulations.

In its deliberations on the regulatory treatment, IWG-4 did not reach consensus on this issue, but did agree that a proposal on this subject should go forward to WRC-2000. IWG-4 also agreed that the general approach to be taken with respect to the 12/13/14 GHz band should also be taken for the 27.5-30 GHz band.

The three options for such a proposal that were identified and considered by IWG-4 are presented below:

Option 1: Propose to suppress the current Section VI of Article S22 of the Radio Regulations. Thus no off-axis power limitation for the FSS would be included in the Radio Regulations in either Ku-band or Ka-band.

Option 2: Propose to incorporate by reference an ITU-R recommendation that would be developed (or suitably modified from an existing recommendation) to include appropriate values for Ku and Ka-band FSS Earth-to-space frequency bands.

Option 3: Propose FSS off-axis power limits in Section VI of Article S22 for all Earth-to-space frequency bands (Ku and Ka) that are identified in Resolution 130.